

Environmental Education Centers

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Introduction:

This report explores the issues involved in constructing an environmental education (EE) center; what the nature of environmental education is; how teaching practices for EE differ from those in standard educational facilities and what types of facilities are needed to enhance learning about the environment. The research from this report draws from a variety of essays, reports and studies done by education experts, child psychologists, naturalists and designers (comprehensive bibliography of source material included). It also draws from existing architectural examples of current EE centers around the country. These examples are included in section 5. This report is an attempt to isolate what type of architectural endeavor – or lack thereof – is most conducive to different aspects of educating children, young adults and ourselves in, about, and for the environment.

1. What is Environmental Education?

“Environmental education is a learning process that increases people's knowledge and awareness about the environment and associated challenges, develops the necessary skills and expertise to address the challenges, and fosters attitudes, motivations, and commitments to make informed decisions and take responsible action” (UNESCO, Tbilisi Declaration, 1978).

“Environmental education is a lifelong learning process concerned with the interrelationships among components of the natural and human made world leading to responsible environmental stewardship.” (Pennsylvania Department of Environmental Protection)

“Put simply, environmental education is all about learning how to care for the earth, other people and ourselves.” (Queensland Department of Education)

2. What is an Environmental Education Center?

There are hundreds of varieties of environmental education (EE) centers throughout the world, all very different. From greenhouses and weather stations built by students behind elementary schools, or mapped and guided hiking trails, to extensive aquariums and multimillion dollar themepark-like “edu-tainment” centers. What they all have in common is that they exist to teach social

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responsibility and appreciation for our environment. They are all learning laboratories conceived with the purpose of fostering a sense of stewardship in visitors, a desire to protect the natural world, and a re-linking of our humanity to nature.

Typical environmental education centers often contain teaching facilities and classroom, conference facilities, demonstration and auditorium spaces, interactive laboratories and exhibits, extensive libraries, varieties of hands on learning opportunities such as gardening areas, integrated trail systems for nature hikes, bird watching, composting, water harvesting and recycling programs. Many centers are built on the camping model with the belief that the best way to understand nature is to spend prolonged periods immersed in it. These types of centers are equipped with cabins or other sleeping facilities, and dining halls, as well as instructional and interactive areas. Many centers are geared particularly towards one age group, while others attempt to provide facilities to reach out to entire communities.

3. Environmental Education and Architecture: Gearing the built environment to teach respect for the natural environment.

The human mind is hard-wired to learn about the environment directly from the environment. The initial and continuing survival of our species for almost all of human history depended on an innate understanding and an intimate relationship with the processes of nature. Through the evolution of our species these links have been impressed into our genetic code, handed down from generation to generation – ensuring our place within the speciation of our planet.

Millions of years of this collective genetic memory have granted us the pre-disposition to understand the natural world in an empathic way. Unfortunately modern lifestyle and traditional education practices separate us physically from our environment and form a rift between our learned natures and that primordial connection. In an attempt to better the environment through reeducation, EE programs throughout the world are attempting to repair those precious broken bonds.

Environmental education is not best conveyed through traditional classroom teaching methods. A separation between the student and the subject matter does not help foster that important empathic bond that needs to be forged between a person and his/her environment in order to cultivate a sense of stewardship. Environmental education is concerned with more than awareness and information dissemination. At its best, this field attempts to re-instill the idea that we as humans are not separate from nature,

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and from this knowledge create new patterns of behavior in relation to the natural world. Obviously traditional abstract cause and effect teaching (we must do this in order to fix that) is not the most effective way of achieving these goals. It is very difficult to teach behavior modification from a text book. Emersion teaching is truly the most effective method. Environmental issues are complex and far reaching, and talking about them in a classroom or through a text book abstracts and separates these issues from everyday life. Students need to relate to these ideas first hand – in a real physical way to begin to develop a true understanding. In order to effect real change in the way students relate to the environment they should do more than learn about issues – they should internalize them. EE should strive to re-insert the idea of environmental stewardship as natural instinct. The wiring is already there in each of our brains – it's just a matter of repairing a few connections.

In order to achieve this sense of emersion and integration between the student and nature; subject matter, teaching methods and the learning environment can be interwoven within environmental education facilities for the greatest effect. And since students of different ages learn about nature through very different environmental interactions – age appropriate learning environments can be created within these facilities to help foster the most efficient and long lasting results. (White, 2001)

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A. Learning And the Environment – Early Childhood (Birth through 6 years)

“Tiny humans begin their journeys in the haven of family – they test their wills against the giants, the grown-ups, as they struggle to define a unique relationship to the world. Each moves from there into the land, adventuring. By forging connections with plants, animals and land, by finding ways to experience some relationship to the earth, individuals can gain a sense of worth that is connected with the natural world.” (Nabhan & Trimble 1994, p.23)

Young children experience the natural environment in a very different way than adults and older children. We are all born with an innate connection and empathy for the environment. We are all preprogrammed to learn from the natural world. It is an unending supply of sensory stimuli which is the type of data that the developing brain recognizes and begins to assimilate into information to teach itself about the world.

The responsibility of environmental education at this age is only to preserve and strengthen that innate connection. Offer the child a learning environment filled with stimuli and natural elements designed to feed the young brain, while providing a safe and secure context that will give the child the confidence to begin his/her exploration of the natural world around. Young children don't need to be taught about nature – they only need to experience it. If interaction isn't encouraged properly studies have shown that children effectively separated from nature will very quickly begin to develop an aversion to it. (White, 2001)

So what type of environment will actively achieve these ends? Children at this young age are already beginning the move towards autonomy in the world. It is very important to give them places in which they feel that they can interact on their own terms. Environments and activities that are too structured can cause frustration; situations with too little stimulation will cause boredom and dissatisfaction. Places that are designed on an adult scale can be intimidating and disassociating. Children begin to “misbehave” when bored, frustrated, scared, under stimulated or overly challenged. They have a deep need to be able to interact with environment in a basic physical way.

At this young stage children actively seek out nest-like environments. They make forts with couch cushions and huddle under trees. They play in leaf piles and under beds. Small intimate environments afford them a feeling of safety where they feel secure to explore and control their surroundings. The young child delights in the “secret niche”. (Nabhan & Trimble, 1994)

Even at the upper end of this developmental stage the child's focus is small and centered. There is no big picture. Young children see bits and pieces – they are much more interested in

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pebbles then canyons. (Heerwagen & Orians 2002, pg. 38) Abstract concepts that are too big for them cause frustration that manifests in a boredom reaction. (White, 2001) They want to learn about the earth by digging in it, playing in it, exploring it – not through pictures and filmstrips. They want to learn about plants by how they smell and taste and feel – what color they turn fingers when they are mashed between them.

"The exploring creating child is not making art so much as using the landscape as a medium for understanding the world by continually destructing/reconstructing it. Where is this vital activity to be carried on if every part of the child's environment is spoken for to meet the economic social and cultural needs of the adult community?" (Moore, 1986)

Natural curiosity about other species is a predominate characteristic of this stage in life. Empathic associations with nature are easily strengthened by giving children access to animals. They are fascinated with them, there is a feeling of solidarity with these other creatures as they sense within them a similar outlook on the world – driven by curiosity and tempered by uncertainty and fear. There is a desire to initiate them into their tribe.

Another critical aspect of environmental learning in this age group begins to occur around age 4. At this age children exhibit the ability to begin to describe their environment in relation to landmarks. This marks the beginning of the ability of mental map-making. The concepts of way finding and directional association begin to make sense. They begin to develop associations between objects and situations. These skills can be fostered by placing children in environments that are tied together by sequences of recognizable events. (Nabhan & Trimble, 1994)

Architectural Response:

The learning environment for the young child should respond to a child's developing sense of adventure and autonomy. It should offer a strong and direct connection to nature. It should offer nests of comfort and safety. It should be an environment flexible enough to allow the child to create micro-environments within it. It should be built to the scale of children, and offer opportunities to explore and challenges to overcome. It should be tactile and visual and audible. "It should respond to a child's sense of territory, boundaries, walls, apparatus and surfaces" (Sutton-Smith, 1990) It should put them in close proximity to plants and paint, animals and art, sky and sun, stars, ponds, bugs and berries.

Children at this age derive a sense of magic and mystery from nature that should be preserved and encouraged. Giving them magical places to learn in through play, which are effectively integrated with the natural environment, is critical.

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B. Learning In the Environment. – Late Childhood (7-11 years)

At this age environmental exploration takes a more focused purpose. Children begin to explore their environment not solely for the sake of exploration – but, with the developing ability of abstract thinking – the child begins to strive to learn his/her place within the environment.

This is the time in a child's development when acculturation and moral development really progresses. High level of cognitive thinking begins the questioning and expanding of perspective. The Child wants to move out into the greater world, leave the nest, experience nature on a grander scale. Camping trips and nature hikes are powerful learning opportunities at this stage.

Pattern recognition becomes a driving force in the brain's development and the child begins to define a bond with nature by using the potent tools of *naming* and *mapping*. (Nabhan & Trimble, 1994) Nature journals and science and art projects help foster this process by giving the students tools to identify similarities and differences between plant and animal species, rocks and minerals, weather patterns, topographic features – anything they can see in the world around them

This is a time of actively seeking knowledge. At this point children become interested in the science of nature. Scientific experiments and demonstrations are fascinating. They want to see the why and the how of things. Interest in animals is still a strong force, and they can bring out the care-giver instinct in children and teach valuable environmental and social issues. Animals are also very therapeutic to emotionally or physically disabled children at this age, and can provide remarkable changes in physical and mental health. (Katcher, 2002)

At this age interests in growing things begin to take hold. This is a great time to introduce children to gardening, composting and recycling/adaptive reuse in hands-on applications. Large scale demonstrations and interactive models are effective teaching tools at this age. Children begin to learn about and understand social responsibility in the greater world.

Architectural Response:

The learning environment for the older child is quite different than that of the young child. While indoor spaces should still integrate with outdoor spaces and nature as a whole, and still cultivate a sense of adventure and discovery - there are substantially different needs to be addressed. Children are ready to integrate learning with nature on a grander scale. Depending on the curricula – spaces can become highly specialized – science labs, weather stations, wind towers. Indoor and outdoor spaces need to be larger to accommodate activities that encourage communion with

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nature – such as scavenger hunts, mapping, in some cases - archaeological digs. Wild outdoor play areas can be integrated with orderly gardens and greenhouses, or biomes and micro-habitats. The built environment should mix with the natural environment in an interesting and important way.

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C. Learning For the Environment – Adolescence to Young Adulthood (12-17 years)

This is a complicated stage in development for environmental education. If a young person has not had much exposure to nature up to this point in his/her life – there is a possibility that biophobia (the fear of, or dislike for the natural world) has begun to set it. Conversely – children that have been brought up with nature begin at this age to feel very protective of it. (White, 2001)

One of the most important developments that separates this age group from others is the desire for social interaction. Socializing becomes the driving force in the life of the American teenager – and creating environments in nature that encourage socializing and group activity can be a great tool for reaching adolescents experiencing biophobia, as well as those comfortable in natural surroundings. (Kaplan and Kaplan)

With the desire for socialization also comes the awareness of social responsibility. Teens become interested in the big issues. And they now have the ability to participate in intelligent, informed social discussion. Their natural tendency toward “teenage rebellion” makes them interested in looking into the fallibility of what they have been taught by authority figures. This is an age when young people begin to question learned behaviors. This can actually be an asset to environmental educators. Acting on the students’ desire to question what they have been taught, it gives a unique opportunity to create projects that look into very deep environmental questions. These students can be great researchers into the hidden issues of social and environmental policy.

Hands-on learning continues to be very important at this stage. “Young people have a preference for gathering new information at their own pace to expand and enhance what they already know.” Science and art are still wonderful teaching tools. Access to libraries and the internet is important so that they can research their causes and be able to take informed action

These young people are passionate and emotional. Young teenagers are often restless and feel a need for taking action. They have a desire to be liked and accepted, which will often manifest itself in ways that educators perceive as a negative and destructive. Acting out is common in this age group as a result of young people searching for a channel for their energy and frustrations. Environmental education can be used to redirect this energy by encouraging these young adults to take actions that demonstrate competence and show helpfulness to others – meaningful actions. This is the perfect time to teach responsible action through local environmental activism. Local environmental action and community involvement causes visible results. It can help stem frustration by showing young people that they do have power and the ability to change things in the world. And locally

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visible actions can teach personal responsibility for distant causes. (Thomashow)

It is also a time to strengthen connections to nature through a different kind of action. At this stage in development young people possess high levels of strength, endurance and agility. They enjoy showing off and testing their limits. They like exploration of a more risky nature. (Kaplan and Kaplan) Obstacle and confidence courses are great ways of getting young people out into nature and strengthening those natural bonds. Activities like boating and rock climbing give them a feeling of independence and control.

Architectural Response:

A primary goal of the learning environment for this age group should be to overcome biophobia. Many young adults with limited access to nature growing up will be experiencing this phenomenon. Creating spaces within the natural environment that encourage social interaction and group activities is a powerful method of achieving a level of comfort for these students, and because this age group is primarily focused in social interaction, socializing in nature helps to rebuild bonds in all students.

The learning environment should also respond to the students need to test their limits and give them opportunities of perceived danger to help them test their mettle and allow for friendly social competition. Confidence courses provide thrills while building teamwork skills, immerse students in nature, and give them some opportunity for showing off in front of their peers.

Interior spaces should continue to relate strongly to nature. Library and computer facilities are important for research and communication.

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D. Learning With the Environment – Continuing (18+ years)

Many people reach adulthood with a very limited knowledge of and connection to the natural world around them. The demands of “the real world” clamor for more and more attention as a person moves into higher education, jobs and careers, families – pushing natural connections and instincts deep into the unused areas of the human mind. But within everyone exists an inherent willingness to come back to nature; it is built in to the human genetic code. For many it is completely suppressed and seemingly unreachable – but for others it is very strong. Continuing education in the environment teaches how to integrate nature back into our lives.

The fully developed mind is interested in cause and effect relationships. Abstract concept teaching is fine – but it is still important to avoid teaching in a vacuum by separating the student completely from the subject matter. Active participation in local politics is effective teaching tool. Adults are very interested in “real” issues that effect local environments, their communities and their families. Providing space for a community forum could be an important addition to an adult education center.

The developed mind is also interested in pattern recognition. An emphasis on natural rhythms of earth and natural rhythms of the body can help foster a thought process where people perceive themselves in relation to nature – not separate from it.

Another aspect of adult education is teaching adults to teach about the environment: educating educators. It is important that their learning environment can demonstrate the principles that they are learning to instill in others.

Architectural Response:

The learning environment for adults can respond to adult methods of information integration; their ability to appreciate metaphor and abstract concept. It should emphasize cause and effect relationships by integrating natural processes into their built environment – techniques they can observe such as rainwater harvesting and adaptive reuse. The mind’s affinity for pattern recognition can be sparked by integrating patterns found in nature with the built environment. Providing indoor/outdoor areas for meetings and other gatherings helps rebuild ties. Areas for advancing learning, such as botany and astronomy and environmental technology help develop new or forgotten appreciations.

Education facilities for adults should be as interesting and integrated as those of other age groups.

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4. Environmental responsibility and Architecture: How the built environment can help teach lessons of conservation, sustainability, responsibility and stewardship.

The facilities for housing an environmental educational program should strive to teach by example. The architecture should seek to embody the curriculum of conservation in the design of the structures themselves.

This is an opportunity to look at buildings in an atypical way - the architecture for such a facility should not imply or assume a separation from the natural environment. It should blend with it – seamlessly, harmoniously, and with great enthusiasm.

The use of recycled materials, passive heating and cooling, wastewater reclamation, energy conservation and production make the structures teachers. Shading and landscape design, use of outdoor rooms, bringing the outdoors in, natural lighting, use of color, vegetation, water, layout, lighting and noise can achieve a balance and harmony with nature that delights and inspires.

Creating this facility also creates opportunity to teach important relationships between ecology economics and architecture. It can demonstrate difficult to understand issues like life cycle costs, and what is the actual total energy embodied in a material; including the resources consumed in its production, the concurrent pollution created in the processes and what the projected cost of cleanup could be. (Orr, 1994)

The structures should encourage mindfulness in those who use it. Functions of buildings can demonstrate cause and effect such as eco-friendly construction. Actions such as storm water reclamation, passive cooling and solar energy use can be articulated as they work to make the center function; demonstrating the actual principals of fully sustainable design at work for everyone to see.

This is an opportunity to teach the beauty and cost effectiveness of environmental architecture to students who can learn those principles and propagate them in their own building choices later in life.

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5. Architectural Examples:

Camp Arroyo Environmental Education Camp - Livermore, California.

Cost: \$215 per person for 5 day program.

Facilities: 138 Acre Privately and State funded Environmental Education facility that provides accommodations for students and special needs children for extended stay in groups up to 144 people (including counselors). 12 sleeping cabins with restrooms accommodate 12 people each. The dining hall seats 200 people and includes an indoor and outdoor stage. There is a 3500 square ft. swimming pool, arts and crafts center, challenge courses.

Living and learning facilities serve as examples of sustainable design. The site incorporates reclaimed water, passive cooling and heat avoidance strategies, water conservation and reclamation, photocells, building materials with lifetime low-impact characteristics. Adaptive reuse and new construction turned this former sanitarium in an arid California oak forest into an environmental science facility for middle school children during the school year and an educational summer camp for children with life threatening illnesses of all ages.

The Curriculum is intensive hands-on project based around one of 4 overarching themes: Wild Places: Hiking and Nature; Voices of the Past: Ohlone Indian Lifeways; Food Gardens and Worms: Organic Gardening; and Everyone is a Designer: Construction with Recycled Materials. There are also recreational activities such as night hikes, swimming, arts and crafts and campfire circles.

IslandWood Center - Puget Sound

Cost: \$400 per student for 4 days (IslandWood subsidizes \$200)
\$100 per chaperone (8:1 ratio) plus transportation cost.

Facilities: 225 Acre Environmental Education Camp. There are 3 lodges available for overnight accommodations. Each lodge is set up with a common great rooms and dormitory style rooms that sleep five and share a bathroom. Each lodge accommodates 32 students and 4 chaperones on overnight trips. There is a large dining hall with composting program that all students participate in, classroom buildings made to demonstrate responsible building techniques, a floating classroom in a 4 acre pond, wet lab, 2 general sciences labs, straw bale art studio, forest canopy tower, computer labs, and an onsite wastewater reclamation facility.

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Sustainable building strategies are used throughout the site including reclaimed and recycled wood flooring and framing members, water reclamation and water use monitoring, solar energy collection, passive cooling, fly-ash concrete, composting toilets, alternative heat sources and rainwater harvesting.

Curriculum focuses on a 3 tier approach to adventure based learning: Science Facilities for energy creation, gardening, sustainability and conservation. Emerging Technologies Facilities for scientific research, measuring, documenting, collecting, interpreting, presenting and managing data. Arts Facilities for creative expression.

The site encompasses 6 distinct ecosystems and there is a learning facility provided in each.

Yosemite National Institutes – Olympic Park Institute – Olympic Peninsula, Washington

Cost: Program costs range from \$260 – \$1800 per person depending on the program and length of stay.

Facilities: Located within Olympic National Park – a 95% Wilderness park covering the Olympic Peninsula of Washington state. The facilities on the site include an historic inn converted into a lodge that serves as dining room, meeting rooms and science lab. The lodge can accommodate groups up to 100 people. Other gathering areas exist outdoors, including a covered gazebo, 3 sided log shelter with stone fireplace on the lake and a campfire amphitheater. Seven heated cabins serve as overnight accommodations; each has a small common area and 4 sleeping rooms for a maximum of 24 people per cabin.

Curriculum is very broad and varies from typical 3-5 day science and nature programs with emphasis on team building to 19 day long Environmental Leadership Programs that offer intensive in-depth exploration of environmental issues for 11th and 12th graders.

Desert Outdoor Center – Lake Pleasant, Arizona

Cost: School Visits - \$20 per day per person
NPO's - \$27 per day per person
Public (min. 25 people) - \$36 per day per person plus kitchen fees.

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Facilities: A complex of environmentally sensitive buildings and hiking trails located on the east side of Lake Pleasant in Maricopa County Arizona. The complex includes a science lab, computer room, resource room, lecture hall, Kitchen, large multi-purpose room, amphitheater and dormitories to accommodate up to 100 people.

Curriculum: Groups can schedule a day program from a list of available topics or use the facilities to teach their own program. The available day study topic list includes: microbiology, archaeology, geology, bat studies, insect studies, desert botany, team building, journaling, park management, tracking, meteorology, desert survival, eco-systems, ornithology, herpetology, and mapping.

North Cascades Environmental Learning Center – North Cascades National Park

Cost: Basic program costs range greatly and are evaluated on a case by case basis in an attempt to accommodate lower income participants.

Facilities: New residential campus is being constructed to provide environmentally sensitive buildings for learning including a multi-media classrooms and science library with computers and web access, aquatic and terrestrial classrooms, overnight accommodations for 46 participants and 12 staff, outdoor learning classrooms and amphitheaters, lakeside dining hall and community center. This new facility is designed to enhance and anchor the camping and facility based programs that exist throughout the expansive park system. Currently the programs utilize a wide variety of parks, hostiles, farms and ranches to conduct the environmental programs that stretch throughout the world's largest contiguous body of protected lands.

Indiana Dunes Environmental Learning Center - Chesterton, Indiana

Cost: 3 – 4 day programs run about \$90 – \$100 per student.
1 – 2 day programs run about \$54 per student.

Facilities: 15,000 Acre Environmental education camp with 10 heated and air conditioned cabins, restrooms and shower facilities to accommodate groups up to 80 people. Sleeping cabins are heated and cooled and accommodate 8 people each (7 students and 1 chaperone) There is a multi-purpose building that serves as classroom, laboratory, meeting area and dining hall. Outdoor fire

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circle accommodates large groups and rope and challenge courses are set up along hiking trails.

Hands-on programs focus on 4th-6th grade students. Center also serves as a teacher training facility, community teaching center, environmental retreat and provides a setting for a wide variety of other programs.

Alabama 4-H Center - Columbiana, Alabama.

Cost: 3 day trips \$85 per student

2 day trips \$43 per student

264 Acre woodland park that accommodates individuals and groups as large as 200 people for camping, education, meetings and seminars, and general recreation.

Nature and technology programs teach about rain forests, river ecology, species identification, astronomy and various other hands on educational activities. Programs include wildlife tracking, canoeing, astronomy, snakes of Alabama, water quality, tree identification, river ecology, eco-adventures in the rain forest. Numerous indoor and outdoor learning environments.

Camp Thunderbird Environmental Education Center - Lake Wylie, South Carolina.

Cost: \$575 per student for 5 day session.

280 Acre facility containing heated cabins, bath and shower facilities, dining hall, large meeting rooms, indoor aquatic study facility, recreation hall, classrooms and administration.

Programs include Forest Ecology, Aquatic Ecology, Wildlife Ecology, Recycling, Wildlife Studies, Pioneer class, Astronomy, Group Dynamics, Bird Study, Orienteering, and more. Instructional areas include forest sites, compass courses, lake study areas, a star lab planetarium, a progressive ropes course with a 45', three-sided climbing tower, alpine tower, an educational garden, and bird feeding stations.

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Additional Web Links

<http://www.americanrivers.org/>

<http://www.blm.gov/education/LearningLandscapes/menu/states/index.html>

<http://www.camparroyogrande.org/>

<http://www.ijams.org/Education.htm>

http://weblinks.schoolsgogreen.org/links/weblinks_enved_cntr/

http://www.lbwf.gov.uk/forest_centre/suntrap/suntrap_cur.stm

<http://www.fourcornersschool.org/default.htm>

<http://www.nps.gov/indu/learning/index.htm>

<http://www.udayton.edu/~meec/>

<http://www.goshen.edu/merrylea/>

http://www.schoolguide.co.za/acres_africa.asp

<http://www.neetf.org/>

<http://www.cees.iupui.edu/Education/Index.htm>

<http://www.sric.org/>

<http://www.goshen.edu/merrylea/BUILD.HTM>

<http://www.edu-source.com>

Water Research Summary

An idea for teaching the students water conservation at the Oliver Ranch School is to establish a minimum amount of water usage as a goal and to have the children practice what they are learning by striving to meet this goal. To help set this goal of an appropriate amount of water to consume while teaching these principles, examples of typical communities, and communities that use a minimal amount of water, were studied to indicate a baseline amount of water for each student to use on a daily basis.

Research was completed on several major western cities to compare water usage for large cities in the western United States. This research indicated that there is a large discrepancy in the amount of water used by residents in major western cities. The daily single-family residential water consumption per capita in Tucson, Arizona is 107 gallons while on the other extreme Las Vegas, Nevada uses 230 gallons per capita. Understanding that cities in similar climates can do much to conserve water is evident by comparing these examples.

Ocean vessels, which have a limited water supply, are good examples of communities that must conserve water. Cruise ship and naval vessels have a large population for balancing a baseline, stay at sea for extended periods of time, and have a diversity of functions that use water to offset superfluous water usage associated with living on land with an “unlimited (as peoples’ attitude toward water use indicates)” source of water.

The water consumption of the USS Nimitz, a naval aircraft carrier and a cruise ship, the Carnival MS Holiday, were studied. The Nimitz uses about 67 gallons of water daily per capita and the Holiday uses 86 gallons of water daily per capita. While considering that the functions of these two ships include some that use large amounts of water it does not seem unreasonable to expect the students at the Oliver Ranch School to be able to better the water conservation practiced on these ships.

By applying water conservation principles and making it fun to do so (for example, by making water conservation a competition among class groups) it is not unreasonable to expect the students at the Oliver Ranch School to work towards a goal of using 50 gallons of water daily per student.

Following is a consolidation of the research completed, as well as, the expanded body of the research.

2001 Single-Family residential daily per capita water consumption

Location	gpcd	Estimated outdoor use
Albuquerque	135	65
Boulder	140	75
Denver	159	90
El Paso	122	53
Grand Junction	182	113
Highlands Ranch	140	71
Las Vegas	230	161
Mesa	123	54
Phoenix	144	75
Scottsdale	203	134
Taylorsville	193	124
Tempe	211	142
Tucson	107	38

The indoor average is 69.3 gpcd, the estimated SFR daily per capita outdoor consumption rates can be derived. In general, this variable can be defined as follows:

$$\text{Estimated SFR daily per capita outdoor consumption} = \text{SFR daily per capita consumption} - 69.3\text{gpcd}$$

*Smart Water: A Comparative Study of Urban Water Use
Across the Southwest*

US Water Distribution

Introduction to the Human Dimensions of Global Change, © 1997 Association of American Geographers

Category of Water Use	Percent of Total Water Usage
Irrigation	40%
Thermoelectric power	39%
Public supply	13%
Industry	5%
Livestock, aquaculture	<1%
Domestic	1%
Mining	1%

US typical Household water use

Introduction to the Human Dimensions of Global Change, © 1997 Association of American Geographers

Activity	Estimated water usage
Washing clothes in washing machine	53 g per load
Flushing toilet	5 g per flush
Washing dishes in a dishwasher	22 g per load
Washing dishes with tap running	30 g
Washing dishes in a filled sink	8 g
Running the garbage disposal	4 g per minute
Brushing teeth	2 g
Shaving with water running	20 g
Taking shower (standard head)	6.5 g per minute
Taking shower (low-flow head)	2.25g per minute
Taking a bath	30 g
Washing car with running water	160 g per 20 min.
Washing car with pistol-grip faucet	16 g per 20 min.

International typical Household water use

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Activity	Estimated water usage
Bath	50 g
Shower	2 g per min.
Teeth brushing	1 g
Hands/face washing	1 g
Face/leg shaving	1 g
Dishwasher	20 g/load
Dishwashing by hand	5 g/load
Clothes washing (machine)	10 g/load
Toilet flush	3 g

USS Nimitz www.navy.mil/homepages/cvn68/main

Four distilling units enable Nimitz engineers to make over 400,000 gallons of fresh water a day, for use by the propulsion plants, catapults and crew.
Enough to supply over 2,000 homes.

6,000 crewmembers
400,000 g of fresh water produced per day
 $400,000\text{g} / 6000 \text{ crewmembers} = \mathbf{67\text{g/d}}$

Carnival MS Holiday juneauempire.com/whatsup/092602.shtml

One million gallons of “gray water” (sink, showers, galleys and laundry)
210,000 gallons of sewage
25,000 gallons of oil-contaminated water

1,400 passengers 600 crewmembers
 $1,000,000\text{g of grey water} + 210,00\text{g of sewage} = 1,210,000\text{g}$
 $1,210,000\text{g} / (7\text{days} \times 2000 \text{ passengers}) = \mathbf{86\text{g/d}}$

Per Capita water consumption in selected Countries (WRI values converted to US units)

Country	Avg. Daily Consumption (gal/day)
Africa	
Mozambique	2.7
Botswana	19.3
Egypt	41.6
Europe	
Albania	4.1
Germany	46.2
France	77.3
North & Central America	
Haiti	1.2
Mexico	39.2
US	176.5
Canada	209.4
South America	
Brazil	39.3
Chile	70.8
Venezuela	119.3
Asia	
India	13.3
Israel, Iraq	47.4
Turkey	101.9

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The substantial Single-Family Resident (SFR) consumption disparity from water provider to water provider raises two very important questions: (1) Why are the SFR consumption figures in some municipal water service areas so low, and others so high?; and (2) What are the water providers and their customers with low SFR consumption doing to attain these figures? Though some water managers and public officials have indicated that the potential water savings from conservation efforts is insignificant or already fully “tapped,” this cannot be so if a neighboring city, or a city with a drier climate, is saving more water.

We look at the two primary attributes to SFR water use: indoor residential use and outdoor water use. In contrast to outdoor use, per capita indoor residential water use remains relatively constant from season to season and year to year, and does not vary much from region to region. According to the American Water Works Association Research Foundation (AWWARF) Residential End Uses of Water Study (“REUWS”), the mean indoor residential per capita consumption for the North American cities in the study was 69.3 gpcd (with a range from 57.1 to 83.5 gpcd). The range of per capita indoor use likely is based on variations in social norms, the age and efficiency of household water fixtures, the presence of evaporative coolers, and other factors.

With variations in indoor use being relatively minimal across the region, we can deduce the most of SFR consumption variation reported in the table above results from variations in per capita outdoor water use (i.e., urban landscape irrigation). Yet, there appears to be very little correlation, if any, between water consumption and local climate. With landscape irrigation accounting for a majority of SFR water consumption in most cities, we might expect a direct, distinct correlation between urban water use and climate. However, the water providers with the lowest SFR per capita consumption rate in this study are exposed to very similar climate conditions as the water providers with some of the highest SFR per capita consumption rates in the study. The absence of a correlation between climate and per capita water consumption rates underscores that an “appropriately developed landscape” is defined differently throughout the region. It appears that while some communities have adjusted their urban landscape expectations to coincide with the climate in which they reside, others have maintained their preference for non-native, high-water-use urban landscapes.

*Smart Water: A Comparative Study of Urban Water Use
Across the Southwest*

Interview with Dr. Liz Warren: Oliver Ranch and Surroundings

A draft, created from meeting notes, will be forwarded to Liz for review and corrected as necessary prior to distribution

Lunch meeting April 26, 2004

There is relatively little documented information regarding Oliver Ranch, however, Liz conveyed the following.

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